for permeation measurements (Mocon OxTran 2/20L and Permatran). Table 1 shows the OTR and WVTR values (measured according to ASTM F 1927-98 and ASTM F 1249-90, respectively) measured at Mocon (Minneapolis, Minn.) for several barrier stacks on PET and polynorbornene (PNB), along with some other measured values.

TABLE 1

Sample	Oxygen Permeation Rate ($cc/m^2/day$)		Water Vapor Permeation ($g/m^2/day$)[+]	
	23° C.	38° C.	23° C.	38° C.
Native 7 mil PET	7.62	—	—	—
TransphanJ[1]	>1000			
Native PNB[1]	>1000			
2-barrier stacks on PNB	1			
1-barrier stack	<0.005	<0.005*	—	0.46[+]
1-barrier stack with ITO	<0.005	<0.005*	—	0.011[+]
2-barrier stacks	<0.005	<0.005*	—	<0.005[+]
2-barrier stacks with ITO	<0.005	<0.005*	—	<0.005[+]
5-barrier stacks	<0.005	<0.005*	—	<0.005[+]
5-barrier stacks with ITO	<0.005	<0.005*	—	<0.005[+]

*38° C., 90% RH, 100% O_2

[+]38° C., 100% RH

[1]Measured according to ASTM F 1927-98.

NOTE: Permeation rates of <0.005 are below the detection limits of current instrumentation (Mocon OxTran 2/20L).

As can be seen from the data in Table 1, the barrier stacks used in the present invention provide exceptional environmental protection, which was previously unavailable with polymers. The barrier stacks of the present invention provide oxygen and water vapor permeation rates several orders of magnitude better than PET alone. Typical permeation rates for other barrier coatings range from 0.1 to 1 $cc/m^2/day$. The barrier stacks are extremely effective in preventing oxygen and water penetration to the underlying devices, and substantially outperform other barrier coatings on the market.

Two barrier stacks were applied to the polynorbomene. At a temperature of 23° C., the two barrier stacks reduced the oxygen permeation rate from >1000 $cc/m^2/day$ to 1 $cc/m^2/day$, an improvement of more than three orders of magnitude. The polynorbornene used in the preliminary evaluation was a prototype material and had very poor surface quality (pits, scratches, and other surface defects). It is believed that the oxygen and water vapor permeation rates can be reduced to <0.005 $cc/m^2/day$ by using a better quality substrate material and more barrier stacks.

We have also compared the performance of OLED devices (fabricated on glass and silicon) before and after encapsulation using the barrier stacks of the present invention. After encapsulation, the current density-versus-voltage and brightness-versus-current density characteristics were identical (within experimental error) to the measured behavior of the pristine (unencapsulated) devices. This shows that the barrier stacks and deposition methods are compatible with OLED device manufacturing.

Using a process of flash evaporation of a polymer precursor and magnetron sputtering to deposit the barrier stacks, deposition temperatures are well below 100° C., and stresses in the barrier stack can be minimized. Multilayer barrier stacks can be deposited at high deposition rates. No harsh gases or chemicals are used, and the process can be scaled up to large substrates and wide webs. The barrier properties of the barrier stack can be tailored to the application by controlling the number of layers, the materials, and the layer design. In addition, because the barrier stacks include crosslinked decoupling layers and hard barrier layers, the barrier stacks provide a degree of chemical resistance and scratch resistance.

Thus, the present invention provides a barrier stack with the exceptional barrier properties necessary for hermetic sealing of an OLED. It permits the production of an encapsulated OLED.

While certain representative embodiments and details have been shown for purposes of illustrating the invention, it will be apparent to those skilled in the art that various changes in the compositions and methods disclosed herein may be made without departing from the scope of the invention, which is defined in the appended claims.

What is claimed is:

1. An encapsulated organic light emitting device comprising:

a substrate;

an organic light emitting device adjacent to the substrate; and

at least one first barrier stack adjacent to the organic light emitting device, the at least one first barrier stack comprising at least one first barrier layer and at least one first decoupling layer, wherein the at least one first barrier stack encapsulates the organic light emitting device.

2. The encapsulated organic light emitting device of claim **1** further comprising at least one second barrier stack adjacent to the substrate and located between the substrate and the organic light emitting device, the at least one second barrier stack comprising at least one second barrier layer and at least one second decoupling layer, wherein the at least one first and second barrier stacks encapsulate the organic light emitting device.

3. The encapsulated organic light emitting device of claim **1** wherein the at least one first barrier stack is substantially transparent.

4. The encapsulated organic light emitting device of claim **2** wherein the at least one second barrier stack is substantially transparent.

5. The encapsulated organic light emitting device of claim **1** wherein at least one of the at least one first barrier layers comprises a material selected from metals, metal oxides, metal nitrides, metal carbides, metal oxynitrides, metal oxyborides, or combinations thereof.

6. The encapsulated organic light emitting device of claim **5** wherein at least one of the at least one first barrier layers is metal selected from aluminum, titanium, indium, tin, tantalum, zirconium, niobium, hafnium, yttrium, nickel, tungsten, chromium, zinc, alloys thereof, or combinations thereof.

7. The encapsulated organic light emitting device of claim **5** wherein at least one of the at least one first barrier layers is metal oxide selected from silicon oxide, aluminum oxide, titanium oxide, indium oxide, tin oxide, indium tin oxide, tantalum oxide, zirconium oxide, niobium oxide, hafnium oxide, yttrium oxide, nickel oxide, tungsten oxide, chromium oxide, zinc oxide, or combinations thereof.

8. The encapsulated organic light emitting device of claim **5** wherein at least one of the at least one first barrier layers is metal nitride selected from aluminum nitride, silicon nitride, boron nitride, germanium nitride, chromium nitride, nickel nitride, or combinations thereof.

9. The encapsulated organic light emitting device of claim **5** wherein at least one of the at least one first barrier layers